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ABSTRACT

A study examined the effects of standards on learning in automotive repair programs. This report describes the methods followed to conduct the evaluation and present its main findings. An analysis of covariance design was used to test the hypothesis that graduates of National Institute for Automotive Service Excellence (ASE)-certified automotive repair programs score higher on standardized tests of knowledge of automotive repair than graduates of non-ASE-certified programs. Groups of students from four automotive programs in each of two states (secondary and postsecondary ASE-certified and secondary and postsecondary noncertified certified programs in both Florida and Pennsylvania) were given a test measuring knowledge of eight areas of automotive repair on which ASE certifies programs. The Test of Cognitive Skills, Second Edition was used to adjust the dependent variable scores. In all, 15 secondary-level and 41 postsecondary-level students from noncertified and 33 secondary-level and 47 postsecondary-level students from certified programs were tested. Site visits were also made to each program. The mean test scores (of a possible score of 90) for the secondary-level students from certified and noncertified programs were 57.64 and 47.27, respectively. The mean scores for the postsecondary-level students from certified and noncertified programs were 67.09 and 65.68, respectively. Students from the ASE-certified programs thus scored significantly higher on the standardized test. (MN)

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THE EFFECTS OF STANDARDS ON LEARNING IN AUTOMOTIVE REPAIR PROGRAMS

A Third-Party Summative Evaluation of
the Standards Established by the
National Institute for Automotive Service Excellence

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FOREWORD

The Center on Education and Training for Employment of The Ohio State University is pleased to submit this third-party, summative evaluation to the National Automotive Technicians Education Foundation (NATEF). This evaluation compared programs that were certified as meeting the standards established by the National Institute of Automotive Service Excellence (ASE) to very similar noncertified programs.

The noncertified programs selected for the comparison group had made the initial steps toward obtaining ASE certification, but at the time of the data collection were not certified. An indication of how close some of the comparison programs were to certification is that one of them became certified only two months after providing data as a noncertified program.

Despite the similarity of the certified and noncertified programs, the test results indicate that ASE standards do have a positive influence on the learning that takes place in automotive repair training programs.

The study was designed by Dr. Morgan Lewis, Research Scientist from our Center, in cooperation with Dr. Patricia Lundquist, the manager of the NATEF skills standards project, and Dr. Byrl Shoemaker, consultant to NATEF. Dr. Lewis selected the programs for the study and prepared this report with the assistance of Mr. Weidong Wang, who conducted the computer analyses. The data collection for the project, including the development of the test of automotive repair, was directed by Mr. Lawrence Gill, formerly a Vocational Education Consultant/Testing Specialist with the Vocational Instructional Materials Laboratory of our Center.

On behalf of all those associated with this study, I would like to express our appreciation to the administrators, teachers, and students of the eight programs, secondary and postsecondary, certified and noncertified, in Florida and Pennsylvania who provided the data that made the evaluation possible. Needless to say, without their cooperation this study could not have been conducted.

Ray D. Ryan
Executive Director
Center on Education and
Training for Employment
College of Education
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Introduction

In May 1994, a National Skills Standards Board was established by Title IV of the Goals 2000: Educate America Act. With the passage of this legislation, the nation acknowledged that if American companies are to be effective competitors in global markets, they need workers whose skills are as good as any in the world.

The partners in the automotive industry who created the National Institute for Automotive Service Excellence (ASE), and later the National Automotive Technicians Education Foundation (NATEF)[1], had recognized the need for highly skilled workers more than two decades earlier. The cooperative and voluntary nature of the standards established by ASE served as a model that was adopted for projects to develop standards for other occupations and was incorporated in the title establishing the National Board.

Two years prior to the passage of the legislation, the U.S. Departments of Education and Labor had solicited proposals to select bidders to establish standards for various occupational areas. NATEF was selected by the Department of Education to update and expand the ASE standards. One of the conditions of this funding was that a third-party summative evaluation be conducted to determine the effectiveness of the standards that were developed. This is the report of the third-party evaluation of the standards updated by the NATEF project.

The Center on Education and Training for Employment (CETE), a unit of the College of Education at The Ohio State University, conducted the third-party evaluation. This report describes the methods followed to conduct the evaluation and presents its main finding. The results indicate that students trained in programs certified by ASE have a better knowledge of automotive repair than students in similar noncertified programs. The procedures followed to produce these results are discussed in the following section.

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[1]ASE certifies both programs that train technicians and the technicians, themselves. NATEF is the educational arm of ASE and is responsible for conducting the reviews that determine if programs meet the standards set by ASE.

Method

Hypotheses

These are the hypotheses that the evaluation tested:

1. Students from ASE certified programs score higher than students from noncertified programs on a standardized test of knowledge of automotive repair. This was the primary hypothesis of the evaluation.

2. Students from postsecondary programs score higher than students from secondary programs. This provided a *known-group* validation of the dependent variable.

3. The third hypothesis was a null hypothesis: there is no significant difference in the scores from Florida and Pennsylvania.

4. None of the interactions among the independent variables are statistically significant.

Study Design

A 2 by 2 by 2 analysis of covariance design was used to test these hypotheses. The three dimensions of the design were defined by the following independent variables:

1. Certification: program had been certified as meeting ASE standards or not

2. Level, secondary or postsecondary

3. State where program was located, Florida or Pennsylvania

The dependent variable was the score on a test that measured knowledge of the eight areas of automotive repair on which ASE certifies programs. There was a subtest for each of these areas. The subtests were developed by selecting items from the test bank of the *Ohio' Vocational Competency Assessment, Auto Mechanics.*[2] The subtests for Engine Repair and Engine Performance had 15 items each; the subtests for the other six areas had 10 items each. The highest possible score was thus 90 items correct.

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[2]This is a new, criterion-referenced test developed by the Vocational Instructional Materials Laboratory of CETE. The job analysis on which the test is based was conducted in 1992 and the items were written and tested in 1993 and 1994.

The *Test of Cognitive Skills,* Second Edition (CRM-McGraw Hill 1984) was used to adjust the dependent variable scores. This is an intelligence test that is primarily nonverbal. Using scores on this test (hereafter called TCS/2) to adjust scores on the dependent variable controlled for differences in the intelligence of students that were likely to influence their scores on the test of knowledge of automotive repair. By controlling for individual difference in intelligence, the analysis yielded a more precise estimate of the effect of certification.

Site Visits

In addition to testing students at the end of their programs, NATEF-recruited teams conducted site visits at each of the programs that cooperated in the evaluation. These teams were led by experienced automotive instructors who had been trained by NATEF. Two automotive repair technicians from the localities served by the programs served as the other members of each team. The site visits were conducted in the same way as a regular certification visit. The cooperating schools and colleges were not asked to complete a full self-evaluation prior to the visit, but they did assemble background information about their programs for review by the teams.

Sample

As in any summative evaluation, the most difficult part of the study was defining and selecting the comparison group that would be used to test if ASE certification had a significant effect on the learning that takes place in an automotive repair program. The group that was selected provided a rigorous test of the effects of certification.

The comparison group was selected from automotive repair programs that had made an initial inquiry to ASE concerning certification, but had not at the time of sample selection completed and returned the self-evaluation forms that are the first step in the certification process. The study was limited to automotive repair, because there were inadequate numbers of auto body and truck programs from which to select the certified and not yet certified programs.

Four automotive repair programs, two secondary and two postsecondary, were selected in both Florida and Pennsylvania. One of the programs at each level was an ASE-certified program and the other was not certified, but had made an initial inquiry about certification.

Attempts were made to select certified and noncertified programs in each state that were as similar as possible. Certified programs in high schools, regional vocational centers, and community colleges were matched with similar noncertified programs, controlling, where possible, for the populations and types of geographic areas the programs served.

Results

Validity of the Dependent Variable

As the first step in the analysis, the subtest scores for the eight areas of automotive repair on which ASE certifies programs were correlated with the total scores. These correlations are shown in Table 1. Each of the subtests correlates highly with the total score; the range is from r = .70 to .85. The subtests also correlate with each other significantly, but at a lower level; the range is r = .42 to .66.

TABLE 1

INTERCORRELATIONS OF SUBTESTS FOR EIGHT AREAS OF AUTOMOTIVE REPAIR WITH TOTAL SCORE

	TS	ER	EP	AT	MT	SS	BR	ES	AC
Total Score (TS)	1.00	.79	.85	.70	.79	.73	.73	.77	.78
Engine Repair (ER)		1.00	.66	.42	.61	.52	.45	.56	.55
Engine Performance (EP)			1.00	.49	.66	.56	.53	.58	.61
Automatic Transmission, Transaxle (AT)				1.00	.60	.45	.47	.47	.52
Manual Drive Train and Axles (MT)					1.00	.44	.52	.51	.49
Suspension and Steering (SS)						1.00	.49	.53	.54
Brakes (BR)							1.00	.58	.58
Electrical Systems (ES)								1.00	.60
Heating and Air Conditioning (AC)									1.00

These correlations provide evidence for the construct validity of the test. The intercorrelations with the total score indicate that students tend to perform similarly on each of the subtests. High total scores are associated with low scores on the

subtests. The lower intercorrelations among the subtests indicate they are measuring somewhat different types of knowledge.

The TCS/2 had a modest correlation with the scores on the automotive test, r = .38, and slightly lower correlations with the subtests. The correlations with the subtests ranged from .27 to .36. Intelligence, as measured by the TCS/2, had fairly consistent relationships with performance on each of the subtests, but the subtests were obviously measuring much more than just intelligence. Scores on the TCS/2 accounted for 7 to 14 percent of the variability in the scores on the subtests and total test of automotive repair.

Test Scores by Certification, Educational Level, and State

The analysis of test scores by educational level, shown in Table 2, provides a different type of evidence for the validity of the test. This is a *known group* validation, a comparison of groups that have had different levels of experience with the content area that the test measures. Those with greater experience should score higher. Postsecondary students, as expected, scored significantly higher than secondary students on the test.

Table 2 also provides the comparisons by certification that are the focus of this evaluation. In three of the four comparisons, the certified programs had higher average scores than the noncertified programs, and there is a ready explanation for the one exception, the postsecondary program in Florida.

TABLE 2

MEAN SCORES ON TEST OF AUTOMOTIVE REPAIR
BY CERTIFICATION, LEVEL, AND STATE

	Florida			Pennsylvania			Total		
	Mean	SD	N	Mean	SD	N	Mean	SD	N
Secondary									
Noncertified	43.83	8.35	6	49.56	11.11	9	47.27	10.19	15
Certified	52.42	12.92	12	60.62	13.00	21	57.64	13.38	33
Total	49.56	12.07	18	57.30	13.31	30	54.40	12.71	48
Postsecondary									
Noncertified	61.27	8.70	11	67.30	10.39	30	65.68	10.19	41
Certified	54.25	15.67	12	71.49	6.12	35	67.09	12.01	47
Total	57.61	13.04	23	69.55	8.54	65	66.43	9.72	88

The noncertified postsecondary program in Florida received its certification just two months after its participation in the study. When this program agreed to participate, it had nearly completed its self-evaluation. It used the feedback from this study's site visit to correct the deficiencies noted, submitted its self-evaluation forms, had a NATEF site visit, and was certified.

Even though the noncertified postsecondary program in Florida had higher average scores than the certified program, the analysis of covariance presented in Table 3 still found certification to be statistically significant.

Table 3 indicates that each of the variables used in the analysis was statistically significant. The significantly higher test scores in Pennsylvania were contrary to Hypothesis 3 of the study and contributed to significant interactions that were contrary to Hypothesis 4.

The higher average score for the noncertified postsecondary program in Florida yielded statistically significant interactions among the variables. One of the assumptions of the analysis of covariance is that there are no significant interactions (Berenson, et al. 1983). As noted above, however, the high average for the noncertified program could be easily explained. Consequently, the interactions were eliminated and the analysis run.

The four variables used in the analysis had a multiple correlation of R = .62 with the automotive test scores. The square of R, .38, indicates the proportion of the variability in the automotive scores that could be explained by these four variables.

Because it was necessary to disregard the assumption of no interactions among the independent variables to run the analysis of covariance, another statistical test was run which allowed interactions. This test, *generalized least squares* (Berenson, et al. 1983) is appropriate because it provides an estimate of each effect, main or interaction, while adjusting each effect for all other relationships among the variables. This test thus removes from the certification effect all variability associated with the other variables and their interactions.

Table 4 presents the results of the generalized least squares analysis including all interactions among the independent variables that were significant at the .05 probability level. These interactions account for much of the explained variance. The important point for this evaluation is that even with all explained variation removed, the certification variable remains significant at less than the .05 probability level.

TABLE 3

ANALYSIS OF COVARIANCE OF AUTOMOTIVE REPAIR SCORES BY CERTIFICATION, LEVEL, AND STATE
TEST OF COGNITIVE SKILLS AS COVARIATE

Source	DF	Sum of Squares	Mean Square	F-Value	p. > F
Model	4	8163.29	2040.82	8.95	0.0001
Error	126	13570.45	107.70		
Corrected Total	130	21733.74			
Source					
Certification	1	610.06	610.06	5.66	0.00094[1]
Level	1	2517.41	2517.41	23.37	0.0001
State	1	1953.12	1953.12	18.13	0.0001
TCS/2	1	1700.11	1700.11	15.79	0.0001

Note: Scores on the TCS/2 were missing for five students. Consequently, the automotive repair test scores for these students could not be used in this analysis.

[1]One-tail test with the prediction that scores of students from certified programs will be higher than scores of students from noncertified programs.

Site Visit Results

Results from the site visits had a pattern similar, but not identical, to the test results. The programs were evaluated using the same standards as are used to determine if a program qualifies for certification. ASE has established 10 standards for use in evaluating programs each of which are rated on a five-point scale from poor (1) to excellent (5).

TABLE 4

GENERALIZED LEAST SQUARES ANALYSIS OF AUTOMOTIVE REPAIR SCORES BY CERTIFICATION, LEVEL, STATE, AND TEST OF COGNITIVE SKILLS

Source	DF	Sum of Squares	Mean Square	F-Value	p. > F
Model	8	10245.93	1280.74	13.60	0.0001
Error	122	11487.80	94.16		
Corrected Total	130	21733.74			
Source[a]					
Certification	1	391.23	391.23	4.15	0.0219[b]
Level	1	1055.10	1055.10	11.21	0.0011
State	1	677.15	677.15	7.19	0.0083
Test of Cognitive Skills	1	2547.00	2547.00	27.05	0.0001
Certification*Level	1	577.45	577.45	6.13	0.0146
Certification*State	1	588.36	588.36	6.25	0.0138
Level*State	1	736.64	736.64	7.82	0.0060
Test of Cognitive Skill*Level	1	781.76	781.76	8.30	0.0047

Note: Scores on the TCS/2 were missing for five students. Consequently, the automotive repair test scores for these students could not be used in this analysis.

[a]All variables and interactions that are significant at the .05 probability level or less are shown. Interactions with probabilities above .05 are not listed.

[b]One-tail test with the prediction that scores of students from certified programs will be higher than scores of students from noncertified programs.

The standards regarding the organization, administration, and pedagogy of the program were rated by the team leader, who had been trained by NATEF. The standards regarding the technical aspects of the eight areas of automotive repair shown in Table 1 were rated by all three team members. Table 5 shows the mean ratings for the 10 standards for the eight programs, and the mean test scores of students from these programs.

Because of the way the noncertified programs were selected, they tended to be very similar to the certified programs. The ratings reflect the similarity in the programs. Nevertheless, within the two states, the certified programs received higher average ratings than noncertified programs. The noncertified, postsecondary program in Pennsylvania, however, received higher ratings than the certified secondary programs, and the two certified secondary programs received higher ratings than the noncertified, postsecondary program in Florida.

The rank order correlation between the means of the site visit ratings and the test scores is .77, which is significant at less than the .025 probability level. The major discrepancy is once again the noncertified, postsecondary program in Florida which ranked sixth in the ratings but third in the test scores. As was noted above, this program corrected the deficiencies identified by the site visit and became certified just two months after participating in this evaluation.

TABLE 5

MEAN SITE VISIT RATINGS AND TEST SCORES
OF PROGRAMS PARTICIPATING IN THE EVALUATION

	Program Means	
	Site Visit Ratings	Test Scores
Postsecondary--certified, Pennsylvania	4.77	71.49
Postsecondary--noncertified, Pennsylvania	4.74	67.30
Postsecondary--certified, Florida	4.70	54.25
Secondary certified, Florida	4.69	52.42
Secondary--certified, Pennsylvania	4.64	60.62
Postsecondary--noncertified, Florida	4.54	61.27
Secondary--noncertified, Florida[a]	4.32	43.83
Secondary--noncertified, Pennsylvania	3.91	49.56

[a]Only four of the eight areas certified by ASE were rated for this program. If all eight had been rated, it is likely this program would have had the lowest average ratings.

Discussion and Conclusion

This evaluation provided a rigorous test of the effect of program standards on learning. The noncertified programs were selected to be very similar to the certified programs. The outcome measure of learning used items from a newly developed standardized test. And differences in the intelligence of the students that were associated with performance on the outcome measure were statistically controlled.

The comparison, noncertified programs were so similar to the certified ones that one of them--the Florida, noncertified postsecondary program--changed categories shortly after participating in the evaluation. This program caused the only difference between certified and noncertified program that was not in the expected direction. Even with this discrepancy, however, the statistical tests of the effect of certification were still significant at the .05 probability level.

The results of this analysis make a strong case that certification improves the learning that takes place in an automotive repair program. To provide a rigorous test of the effects of the standards, the noncertified programs were selected to be as similar to the certified programs as possible. It is very likely that if the comparison group had been selected from a more representative population of all noncertified programs, the differences between the certified and noncertified programs would have been larger than those found in this study.

Since this was a summative, not formative, evaluation, it did not attempt to identify the ways in which certification enhances learning, but the results of the site visits give some clues. The most obvious way that standards can influence learning is by ensuring that facilities, equipment, tools, and instruction are relevant to the real needs of the work place. Automotive technicians serve as members of NATEF certification teams to add their knowledge of local practices to the review of programs. Noncertified programs may not have the same level of linkage with the labor market.

The ASE standards also set forth clear objectives for the knowledge and skills students should acquire. These objectives focus instruction and may motivate students by communicating clearly the expectations for satisfactory performance. There is a large body of research that has established that expectations can influence learning either positively or negatively (Rosenthal and Jacobson 1968, Swann and Snyder 1980). It seems unlikely that noncertified programs would have the same degree of clarity in their objectives.

The goal of achieving ASE technician certification may also provide motivation. Students in certified programs know that the instruction they are receiving meets national standards. They can reasonably assume that if they satisfactorily master the skills they are studying, they will qualify for ASE certification after they have acquired the necessary on-the-job experience.

Conclusion

The overall conclusion of this third-party evaluation is that ASE standards have a positive effect on the learning that takes place in automotive repair programs. Students from programs certified by ASE scored significantly higher on a standardized test of knowledge of automotive repair than students from similar noncertified programs. It is highly likely that if the comparison programs were selected to be more representative of all noncertified programs, the differences between certified and noncertified programs would be larger than those found in this study.

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